Student work

How does primary productivity depend on depth in a Lake?

Aim: To see how productivity of algae and *Elodea* changes with depth in a simulated lake.

Prediction: As the depth (% of light decreases) increases the productivity will decrease.

Variables:
Independent: depth – simulated by layers of clear plastic OHP sheets
Dependant: amount of dissolved oxygen
Controlled: reagent bottle, 250cm^3; light source; amount of pond water and length of *Elodea;* time left to photosynthesis.

Materials:
12 reagent bottles
Elodea – 12 pieces in 10cm lengths
Pond water
OHP film
Elastic bands to wrap film around bottles.
Light array
DO probe
aluminum foil

Method:
Collect 12 reagent bottles, 250cm^3.
Label every two bottles as follows: Dark; 100% Light; 65% light; 25% light; 10% light and 2 % light.
The % of light was calculated using a light meter. The Lux reading under the light array was taken and then taken again under 1, 3, 5 and 8 layers of the OHP film. The difference between the first reading and the one under the OHP sheet was calculated and turned into a %.
Fill each bottle with pond water and add a strand of *Elodea*.
Secure the correct number of OHP films around each labeled bottle. Use the elastic bands to hold them in position. Take care not to cover the *Elodea*. Cover the dark bottles in aluminum foil.
Measure the DO in mg/l in each bottle and record in a table – these are the initial readings. Record each bottle three times after stirring the probe gently for 10 seconds.
Place each bottle on its side under the light array. Leave for 5 days.
Record the DO again, three times for each bottle. Record the results.
Work out the averages of each set of bottles.
Using the formulas:
Respiration = initial bottle – dark bottle
Net productivity = light bottle – initial bottle
Gross productivity = light bottle – dark bottle
Calculate respiration, net and gross productivity of each light level.

Results:
Table 1: Initial Readings of DO mg/l in dark and light bottles containing algae and *Elodea*.

Amount of light in bottle	DO mg/l 1st sample		DO mg/l 2nd sample		DO mg/l 3rd sample	
	Bottle 1	Bottle 2	Bottle 1	Bottle 2	Bottle 1	Bottle 2
100%	3.00	3.20	3.10	2.70	3.56	2.80
65%	3.10	3.79	2.90	3.43	2.97	3.60
25%	3.15	3.12	3.50	3.30	3.20	3.90
10%	3.25	3.10	3.40	3.50	3.25	2.99
2%	3.10	3.00	3.00	2.90	3.30	3.20
Dark (0%)	4.00	3.70	3.20	2.90	3.50	3.40

Table 2: Readings after 5 days of DO mg/l in dark and light bottles containing algae and *Elodea*.

Amount of light in bottle	DO mg/l 1st sample		DO mg/l 2nd sample		DO mg/l 3rd sample	
	Bottle 1	Bottle 2	Bottle 1	Bottle 2	Bottle 1	Bottle 2
100%	3.70	4.50	3.98	4.70	4.56	4.60
65%	3.70	4.50	3.50	3.90	3.80	4.20
25%	2.40	3.90	4.00	3.43	3.45	3.40
10%	3.10	3.20	3.38	3.40	2.40	2.79
2%	3.05	2.20	3.50	3.10	2.20	2.30
Dark (0%)	3.00	2.70	2.22	3.16	2.26	2.59

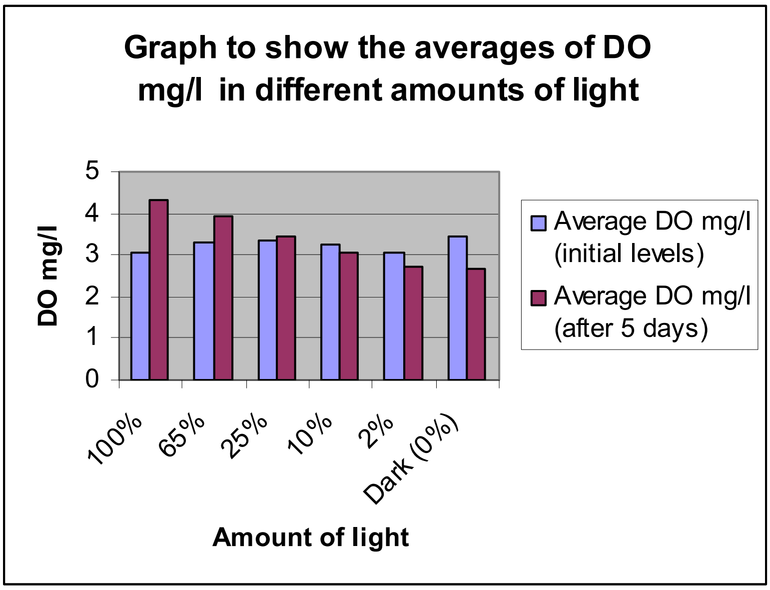
Table 3 : Averages DO mg/l readings of each light level.

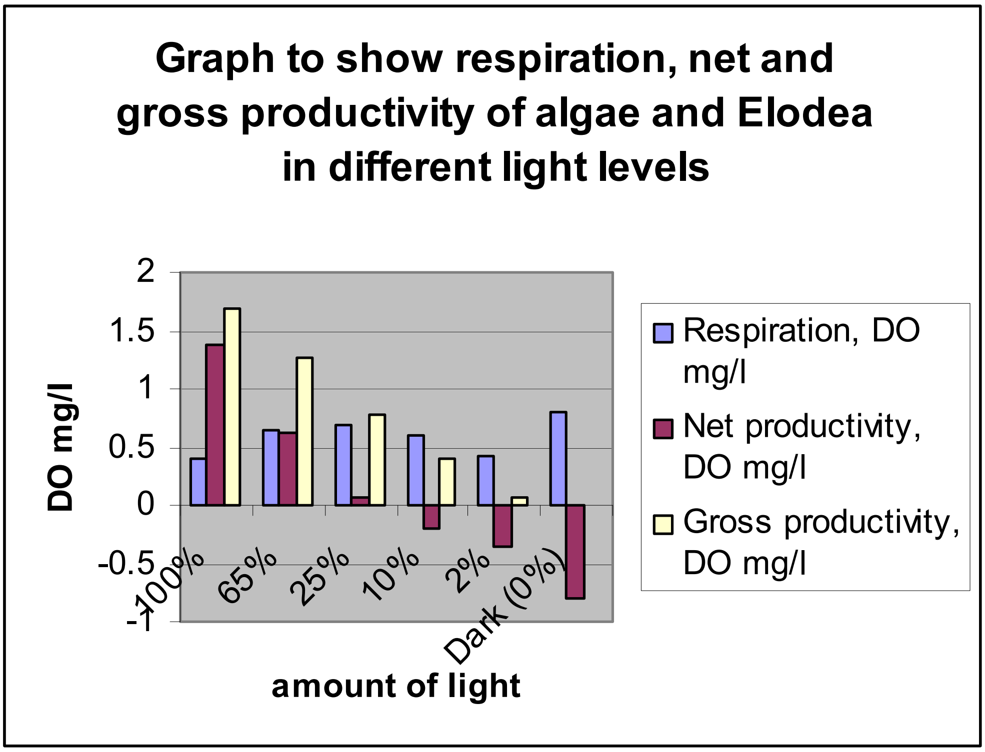
Amount of light in bottle	Average DO mg/l (initial levels)	Average DO mg/l (after 5 days)
100%	3.06	4.34
65%	3.30	3.93
25%	3.36	3.43
10%	3.25	3.05
2%	3.08	2.73
Dark (0%)	3.45	2.66

Table 4:
Calculations of respiration, net and gross productivity using DO mg/l

Formulas are given in the method above.

Amount of light in bottle	Respiration, DO mg/l	Net productivity, DO mg/l	Gross productivity, DO mg/l
100%	3.06-2.66=0.40	4.34-3.06=1.37	4.34-2.66=1.68
65%	3.30-2.66=0.64	3.93-3.30=0.63	3.93-2.66=1.27
25%	3.36-2.66=0.70	3.43-3.36=0.07	3.43-2.66=0.77
10%	3.25-2.66=0.59	3.05-3.25= -0.20	3.05-2.66=0.39
2%	3.08-2.66=0.42	2.73-3.08= -0.35	2.73-2.66=0.07
Dark (0%)	3.45-2.66=0.79	2.66-3.45= -0.79	2.66-2.66=0.00





Conclusion:
My prediction seems to be supported by the results that I collected. As the level of light decreases the amount of productivity also decreases. This can be seen in the results from 100% light to 25% light there is a steady decrease in the net productivity from 1.37 to 0.07 mg/l DO. After this the net productivity is negative indicating that very little photosynthesis is going on at these “depths”.

Discussion:
Photosynthesis needs light to work. Plants start to photosynthesis and produce excess oxygen, which we are measuring in this experiment when the level of light is high enough. At the same time all plants are respiring and so using up oxygen. As we are measuring oxygen amounts in the water then some of the oxygen produced by photosynthesis will be used up and some released to the water.
The respiration amounts for each sample do not vary too much: from 0.40 to 0.79 mg/l DO. So this should not have too much influence on the final results.
The gross productivity shows a steady decline as the light levels drop from 1.68 to 0.07 mg/l DO, having zero when the sample is in the dark – as theory predicts.
Once the respiration factor is taken into account the net productivity shows a similar decline from 1.37 to –0.35 mg/l DO. Indicting that once a negative figure is reached for net productivity then photosynthesis is less than respiration so no excess oxygen is being released to the water.

Evaluation:
The main area of error is with the use of the probe. The DO levels constantly change so it is very difficult to know which number to record. The instructions state that to obtain an accurate reading the probe should be gently stirred for a number of seconds. This was done but was it done in exactly the same way each time – unlikely. This is an inherent error and as the data is so close it means that the whole data set must be suspected. More samples could be taken and possibly then the averages would be closer to the actual amount.
The amount of algae in each sample is uncertain and the length and health of the Elodea could vary enough to upset the results. This could be corrected by using a calorimeter to determine the amount of algae or by adding a known quantity of algae to artificial pond water. The Elodea should be equally healthy – very hard to determine objectively and exactly 10cm in length.